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SPORT EFFORT, HARVEST, AND ESCAPEMENT OF DOLLY VARDEN CHAR *(Salvelinus malma)* IN THE BUSKIN RIVER, KODIAK, ALASKA, 1986

By: John B. Murray

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ABSTRACT

A creel survey was conducted 24 April through 30 May 1986 to estimate sport effort for and harvest of Dolly Varden char (*Salvelinus malma* Walbaum) in the Buskin River. Sport anglers fished an estimated 4,284 angler-hours and harvested an estimated 4,065 adult Dolly Varden char. Age 5, 6, and 7 fish dominated the harvests of Dolly Varden char. The Buskin River Dolly Varden char migrations were counted through a weir operated from 19 April through 2 October 1986. A total of 40,773 emigrant Dolly Varden char and 24,110 immigrant fish were counted through the weir. The estimate of immigrating fish is incomplete as Dolly Varden char continue to enter the system during the winter.

KEY WORDS: Dolly Varden, *Salvelinus malma*, effort, harvest, size, age, escapement, Buskin River, Kodiak, Alaska.

INTRODUCTION

The Buskin River (Figure 1) is centrally located in the urban area of Kodiak Island and receives more fishing effort by anglers than any other water on Kodiak Island. The river contains steelhead and rainbow trout (*Salmo gairdneri* Richardson), Dolly Varden char (*Salvelinus malma* Walbaum), and all species of Pacific salmon (*Oncorhynchus sp.* Walbaum) except chinook salmon (*O. tshawytscha* Walbaum). It supports approximately 63% (32,485 angler-days) of the sport fish effort and 48% of the sport harvest (all species) of all Kodiak lakes and streams (Mills 1986). Buskin River salmon also support the largest personal use/subsistence fishery on Kodiak Island and a commercial fishery that targets primarily on pink (*O. gorbuscha* Walbaum) and coho (*O. kisutch* Walbaum) salmon (Manthey et al. 1984). In 1985, Buskin River Dolly Varden char supported approximately 58% of the total Kodiak area Dolly Varden char harvest (Mills 1986). The sport fishery is directed at anadromous Dolly Varden char during April and May, sockeye (*O. nerka* Walbaum) and pink salmon during June through mid-August, and coho salmon during mid-August through mid-October. Immigrant Dolly Varden char are also caught during mid-summer through fall.

The migratory patterns and stock structure of the Dolly Varden char stocks are not well understood. These stocks are anadromous and migrate not only to the Buskin River, but to other marine and freshwater locations as well. As a result, these fish potentially contribute to fisheries other than the Buskin River fishery. The migratory behavior of these fish may be similar to that reported by Armstrong (1965) who found that anadromous Dolly Varden char in southeastern Alaska normally spend the winter in a lake system and migrate to sea in the spring. During the period of summer ocean residency, Dolly Varden char were found to periodically enter systems other than the overwintering site. Buskin Lake (101.5 surface hectares) is presumed to be the major Dolly Varden char overwintering site for the Chiniak Bay area.

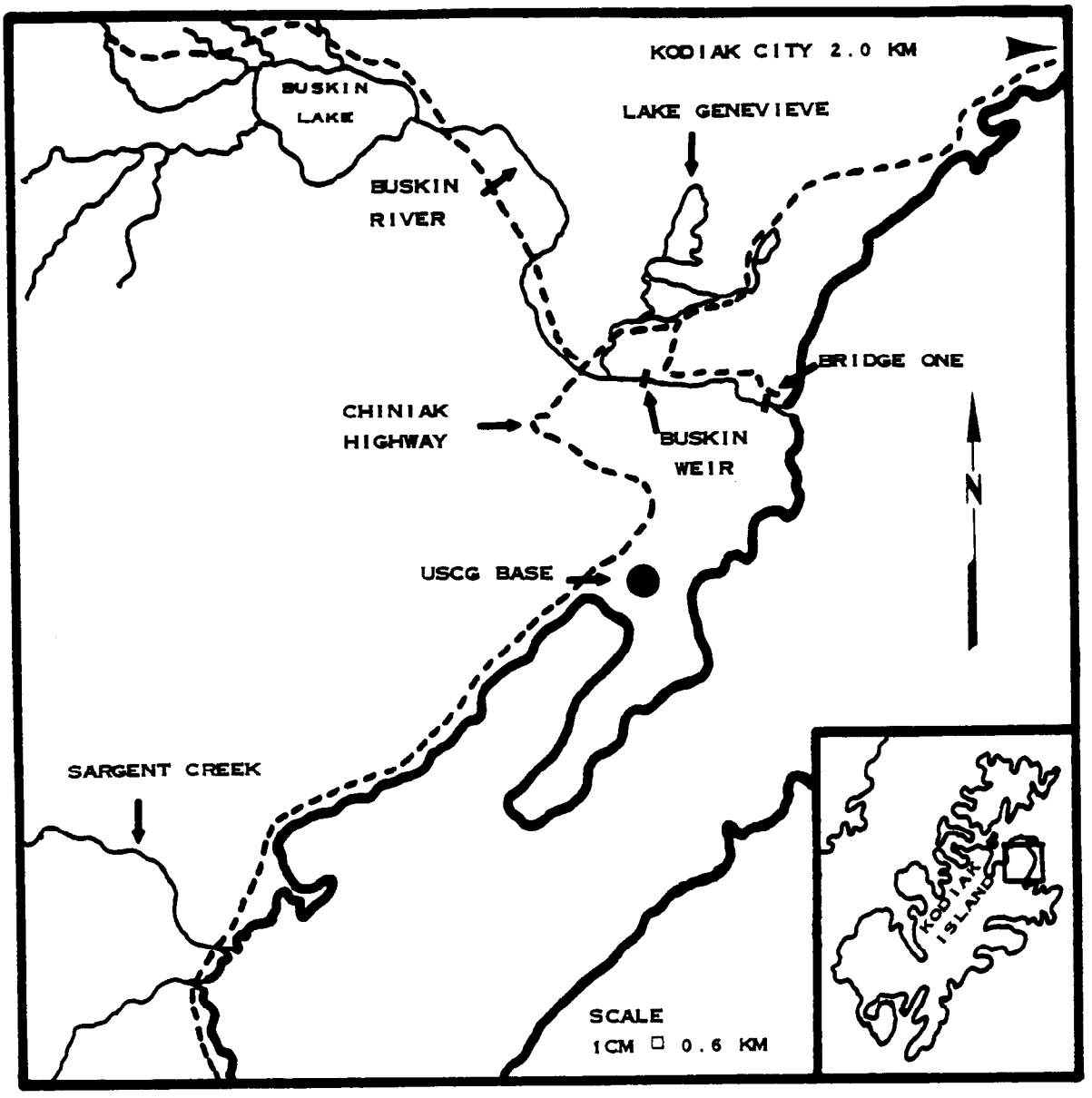

Figure 1. Location of Buskin River, Kodiak Island, Alaska.

In 1985, the Sport Fish Division of the Alaska Department of Fish and Game (ADF&G) initiated a project to estimate the magnitude and composition of salmon, Dolly Varden char, and steelhead trout returns to the Buskin River (Murray 1986). The project consisted of: (1) enumerating escapements through a weir; (2) estimating angler effort and harvest for the spring Dolly Varden char and fall coho salmon fisheries; (3) estimating the age, sex, and size composition of Dolly Varden char and coho salmon in both the sport harvest and the escapement; and (4) identifying migrational patterns and stock structure of Buskin River Dolly Varden char through a tagging program.

The objective of this report is to present baseline data for the Buskin River Dolly Varden char sport fishery and migrations. Tag returns are still being analyzed and only the tagging effort is reported here. Results of that portion of the project pertaining to coho salmon are reported by Murray (in press).

METHODS

Sport Fishery

During 1986, anglers were permitted a daily bag limit of 10 Dolly Varden char and could have two daily limits in their possession (ADF&G 1986). By regulation, sport fishing was not permitted within 100 m of the weir. In addition, the 100 m closed waters upstream of the weir was extended an additional 210 m to encompass a large holding area. This was an unscheduled closure and was in effect during the period 12 May to 9 June 1986.

Study Area:

Dolly Varden char first emigrate from Buskin Lake during mid-April and continue through May or early June. During some years, heavy ice cover on Buskin lake may delay the emigration by 2 weeks. Dolly Varden char immigration from saltwater begins in July and continues into October.

The Buskin River sport fishery for Dolly Varden char occurs throughout the spring emigration and the summer-fall immigration. The sport fishery for both emigrant and immigrant fish generally occurs throughout the river (Figure 1).

Study Design:

A creel survey was conducted on the Buskin River from 24 April through 30 May to estimate sport effort in angler-hours and sport harvest of Dolly Varden char.

Angler counts were conducted following a stratified random sampling design. For the creel survey, the fishing day was considered to be 16 hours in duration (0600-2200 hours). The fishing day was stratified into four time periods: A, 0600-0759 hours; B, 0800-1159 hours; C, 1200-1659 hours; and D, 1700-2200 hours. Sampling effort was

allocated approximately proportional to the number of hours in each period.

Angler counts took approximately 20 minutes to complete and were considered instantaneous (Neuhold and Lu 1957). Angler interviews were completed trip interviews collected by monitoring the major access points and interviewing anglers as they departed the fishery.

The major assumptions necessary for the creel survey are:

1. Angler counts made during the same day and on consecutive days are independent.

2. No significant fishing effort occurs during the hours 2200-0600.

3. Interviewed anglers are representative of the total angler population.

4. The number of anglers interviewed during a day is proportional to the effort on that day.

5. Fishing effort does not influence catch per unit effort.

6. Angler efforts and catches are normally distributed random variables.

Data Collection:

During a selected sample period, a starting time was randomly selected to count the number of anglers. The remaining time in the sample period was spent conducting angler interviews. Angler counts were conducted by walking and/or driving the length of the fishing area as quickly as possible and counting the number of people actively engaged in fishing. Only anglers who had completed fishing were interviewed. The following information was recorded during each interview: number of fish released by species, number of fish retained by species, and total hours fished (to the nearest one-quarter hour).

Data Analyses:

Angler effort was calculated using a stratified random sample design (Schaeffer et al. 1979). Effort was estimated for each location and time frame as:

$$\hat{E} = \sum_{j=1}^{4} H_j \bar{Y}_j$$

with variance

$$V(\hat{E}) = \sum_{j=1}^{4} H_j^2 \, (s_j^2/n_j)$$

where $\bar{Y}_j$ = the mean number of anglers per count in stratum j,

H_j = total number of hours of fishing possible in stratum j,

s_j^2 = the sample variance for angler counts in stratum j, and

n_j = the number of angler counts conducted in stratum j.

The mean effort and mean harvest per angler was calculated for each location and time frame using a two-stage random sample design with days as the primary sample units and anglers as the secondary sample units (Von Geldern and Tomlinson 1973). Arithmetic means were calculated from all completed trip anglers interviewed at a location and time frame.

The variance of mean effort was estimated as (Sukhatme et al. 1984):

$$V(\bar{f}) = [1-(d/D)] \, s_B^2 /d + [\sum_{i=1}^{d} (s_{wi}^2/m_i)]/dD$$

where

$$s_{wi}^2 = [\sum^{m_i} (f_{ik}-\bar{f}_i)^2]/(m_i-1),$$

$$s_B^2 = [\sum_{i=1}^{d} (\bar{f}_i-\bar{F})^2]/(d-1)$$

d = number of days on which sampling was conducted,

D = number of possible days at a location in a time frame,

f_{ik} = effort by angler k interviewed on day i,

m_i = number of anglers interviewed on day i, and

$\bar{F}$ = mean effort per angler at a location during a time frame.

The variance of mean harvest per angler was estimated by substituting individual harvests for efforts in the above formulae.

Harvest per effort, $\bar{h}/\bar{f}$, was computed for each location and time frame. The variance of harvest per effort is approximated by the variance for a quotient of two random variables (Jessen 1978),

$$V(\bar{h}/\bar{f}) = (\bar{h}/\bar{f})^2 [(s_h^2/\bar{h}^2) + (s_f^2/\bar{f}^2) - (2rs_h s_f/hf)$$

where,

$\bar{h}$ = mean number of coho salmon caught per angler,

$\bar{f}$ = as defined previously,

s_h^2 = two-stage variance of $\bar{h}$,

s_f^2 = two-stage variance of $\bar{f}$, and

r = Pearson's correlation coefficient for the h_{ik} and fi_k.

Total harvest (T) was computed as:

$$\hat{T} = \hat{E}\ (\bar{h}/\bar{f});$$

and variance (Goodman, 1960):

$$V(\hat{T}) = [\hat{E}^2\ V(\bar{h}/\bar{f})] + [(\bar{h}/\bar{f})^2\ V(\hat{E})] - [V(\hat{E})\ V(\bar{h}/\bar{f})].$$

Escapement

The Buskin River weir is located 2 km upstream of the river mouth at an area approximately 40 m wide. Both river banks at the weir site are steep and the river bottom is predominantly small rock substrate. The weir is constructed of 21 mm diameter aluminum pipe spaced 21 mm apart.

Adult fish counted through the weir gates were identified by species and the daily totals recorded. When the coho salmon immigration was nearly completed (2 October) the weir was dismantled and a foot survey was conducted to count fish holding below the weir. The immigrant Dolly Varden char count is incomplete as fish continue to enter the river through early winter.

Biological Data

Dolly Varden char from the sport harvest were sampled for age and size data. Sampled fish were measured for snout-to-fork length to

the nearest mm. Otoliths were collected for age analysis and were placed in a black watch glass filled with water and read with a binocular microscope (10 power) utilizing reflected light. Proportional age composition of the harvest was estimated. Letting p_h equal the estimated proportion of age class h, the variance of p_h was estimated using the normal approximation to the binomial (Schaeffer et al. 1979):

$$\hat{p}_h = \hat{p}_h(1 - \hat{p}_h)/(n_T - 1),$$

where n_T is the number of otoliths read.

Tagging

Dolly Varden char were tagged in the Buskin River, other major systems in Chiniak Bay, and several systems in close proximity to Chiniak Bay. Emigrant Dolly Varden char were tagged during the spring in the Buskin River prior to passage through the weir. Fish were seined in the closed waters upstream from the weir. Emigrant fish were also tagged in Afognak Lake. Immigrant fish were tagged during the summer in Olds River, American River, Salonie Creek, Roslyn Creek, and Lake Rose Tead. Immigrant fish were also tagged in Buskin Lake during the fall.

Fish were tagged with a numbered Floy FD 68B anchor tag, measured for snout-to-fork length, and released. Tag return data are currently being analyzed and will be reported at a later date.

RESULTS AND DISCUSSION

Sport Fishery

Mean angler counts for weekends and weekdays were 6.7 and 6.8 anglers, respectively (Table 1). Most of the effort (3,026 angler-hours or 71%) occurred during the weekday fishery. Angler counts by date and daily time period are presented in Appendix Table 1.

Harvest rates for the weekend and weekday fishery were 0.812 and 1.006 fish per hour, respectively (Table 2). Daily summaries of angler interviews are presented in Appendix Table 2.

An estimated 4,065 Dolly Varden char were harvested during 4,284 angler-hours of effort (Table 3). Most of the harvest occurred during the weekday fishery (3,044 fish or 75%). Few Dolly Varden char were released.

A comparison of relative precision for the estimates of harvest and effort (Table 3) shows that most of the imprecision occurred in the estimate of harvest for the weekend fishery. The high degree of variability is attributed to the sporadic nature of the Dolly Varden char fishery; no consistent pattern was obvious for fishing effort.

Table 1. Estimated effort in angler-hours during the Buskin River sport fishery for Dolly Varden char, 1986.

Fishery	No. Counts	No. Days Possible	No. Days Sampled	Counts		Effort	
				Mean	SE[1]	Mean	SE[1]
Weekend	11	11	7	6.7	1.1	1,258	202.1
Weekday	26	26	17	6.8	1.0	3,026	449.3
					Total	4,284	492.7

[1] Standard Error.

Table 2. Effort and catch summary statistics for anglers interviewed during the Buskin River sport fishery for Dolly Varden char, 1986.

Fishery	Number of Interviews	D[1]	d[2]	Effort (hours) Mean	Effort (hours) SE[3]	Harvest Mean	Harvest SE[3]	r[4]	CPUE[5]	SE[3]
Weekend	160	11	7	1.470	0.110	1.194	0.463	0.292	0.812	.096
Weekday	382	26	13	1.494	0.084	1.503	0.225	0.330	1.006	.045

1 Number of days possible for sampling.
2 Number of days sampled.
3 Standard error.
4 Correlation coefficient between angler effort and harvest.
5 Number of fish retained per hour.

Table 3. Estimated effort and harvest during the Buskin River sport fishery for Dolly Varden char, 1986.

Fishery	Total Effort	Relative Precision	CPUE[1]	Relative Precision	Harvest Total	Standard Error	Relative Precision
Weekend	1,258	31.5%	0.912	23.2%	1,021	204.5	39.3%
Weekday	3,026	29.1%	1.006	8.8%	3,044	471.8	30.4%
Total	4,284	22.5%		Total	4,065	514.2	24.8%

[1] Number of fish retained per hour fished.

Escapement

Buskin River weir Dolly Varden char escapement from 19 May through 2 October 1986 totaled 24,110 emigrant and 40,773 immigrant Dolly Varden char (Appendix Table 3). The immigrant counts are incomplete as the weir was removed before the fall Dolly Varden char immigration was completed.

Biological Data

Age classes 3 through 10 were present in the sport fishery sample (Appendix Table 4). The sample was dominated by age 5 (37.7%), age 6 (30.0%), and Age 7 (17.8%) fish. Mean lengths by age groups are presented in Appendix Table 5.

Tagging

Numbers of Dolly Varden char tagged by location are as follows: Buskin River (4,430); Olds River (1,402); American River (560); Roslyn Creek (30); Lake Rose Tead (1,765); and Afognak Lake (1,479).

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APPENDIX TABLES

Appendix Table 1. Angler Counts in the Buskin River Dolly Varden sport fishery, 24 April through 30 May 1986.

Date	WD/WE[1]	Count by Period[2] A	B	C	D
4/24	WD				6
4/25	WD			5	
4/26	WE	1	9		
4/27	WE			7	10
4/28	WD	0			
4/29	WD				
4/30	WD		2		20
5/01	WD	1	1		
5/02	WD		9	6	
5/03	WE				
5/04	WE				
5/05	WD		9	21	
5/06	WD				
5/07	WD				
5/08	WD		11	19	
5/09	WD		5		
5/10	WE	3			
5/11	WE				
5/12	WD				
5/13	WD				
5/14	WD				
5/15	WD	1			
5/16	WD				
5/17	WE		13		
5/18	WE	6			10
5/19	WD			14	21
5/20	WD				
5/21	WD				13
5/22	WD				
5/23	WD				4
5/24	WE		2	2	
5/25	WE				
5/26	WE			11	
5/27	WD	0	0		
5/28	WD			3	
5/29	WD	2			
5/30	WD	0		0	

[1] WD = Weekday; WE = Weekend/Holiday

[2] Period A: 0600-0759 hrs, Period B: 0800-1159 hrs, Period C: 1100-1659 hrs, Period D: 1700-2300 hrs.

Appendix Table 2. Angler effort and harvest data for the Buskin River Dolly Varden char sport fishery, 24 April through 30 May 1986.

Date	WD/ WE[1]	Number of Interviews	Hours		Dolly Varden Char Harvest		
			Mean	Std Err	Mean	Std Err	CPUE
24-Apr	WD	31	0.7903	0.0741	0.0323	NA	0.0408
25-Apr	WD	18	1.1806	0.1883	0.3333	0.2687	0.2824
26-Apr	WE	12	1.5208	0.2186	1..1667	0.5401	0.7671
27-Apr	WE	56	1.5698	0.1824	0.8750	0.3715	0.5574
28-Apr	WD	1	0.7500	NA	0.0000	NA	0.0000
29-Apr	WD	0	NA	NA	NA	NA	NA
30-Apr	WD	65	1.5500	0.1165	0.6000	0.1941	0.3871
01-May	WD	15	1.3167	0.1609	1.0000	0.6928	0.7595
02-May	WD	29	1.3190	0.171	1.6207	0.4585	1.2288
03-May	WE	0	NA	NA	NA	NA	NA
04-May	WE	0	NA	NA	NA	NA	NA
05-May	WD	35	1.3357	0.1456	2.5143	0.3932	1.8824
06-May	WD	0	NA	NA	NA	NA	NA
07-May	WD	0	NA	NA	NA	NA	NA
08-May	WD	47	2.2447	0.364	3.8723	0.3794	1.7251
09-May	WD	11	1.6591	0.1824	1.8182	1.2792	1.0959
10-May	WE	3	0.8333	0.0835	0.3333	NA	0.4000
11-May	WE	0	NA	NA	NA	NA	NA
12-May	WD	0	NA	NA	NA	NA	NA
13-May	WD	0	NA	NA	NA	NA	NA
14-May	WD	0	NA	NA	NA	NA	NA
15-May	WD	1	1.2500	NA	1.0000	NA	0.8000
16-May	WD	0	NA	NA	NA	NA	NA
17-May	WE	14	1.1786	0.195	1.0714	0.7981	0.9091
18-May	WE	47	1.4096	0.1209	2.2766	0.2894	1.6151
19-May	WD	55	1.8273	0.1411	2.1091	0.4028	1.1542
20-May	WD	0	NA	NA	NA	NA	NA
21-May	WD	32	1.2656	0.2245	0.6250	0.2500	0.4938
22-May	WD	0	NA	NA	NA	NA	NA
23-May	WD	16	1.4375	0.211	0.7500	0.4082	0.5217
24-May	WE	17	1.2059	0.1745	0.1176	0.0000	0.0976
25-May	WE	0	NA	NA	NA	NA	NA
26-May	WD	11	2.1136	0.3292	1.2727	0.3114	0.6022
27-May	WD	20	1.0250	0.1758	0.5000	0.2887	0.4878
28-May	WD	8	1.4375	0.4193	0.5000	0.2041	0.3478

[1] WD = Weekday; WE = Weekend/Holiday

Appendix Table 3. Counts of emigrant and immigrant Dolly Varden char through the Buskin River weir, 1986.

Date	Emigrant Dolly Varden	Immigrant Dolly Varden	Date	Emigrant Dolly Varden	Immigrant Dolly Varden	Date	Emigrant Dolly Varden	Immigrant Dolly Varden	Date	Emigrant Dolly Varden	Immigrant Dolly Varden
4/29	6		6/08			7/17		766	8/25		35
4/30	17		6/09			7/18		351	8/26		40
5/01	1		6/10			7/19		507	8/27		35
5/02	3		6/11			7/20		633	8/28		11
5/03	3		6/12			7/21		708	8/29		13
5/04	0		6/13			7/22		1,232	8/30		15
5/05	0		6/14			7/23		2,738	8/31		16
5/06	17		6/15			7/24		1,611	9/01		13
5/07	16		6/16			7/25		861	9/02		12
5/08	0		6/17			7/26		1,975	9/03		7
5/09	1		6/18			7/27		1,867	9/04		1
5/10	0		6/19			7/28		1,255	9/05		28
5/11	0		6/20			7/29		365	9/06		38
5/12	0		6/21			7/30		487	9/07		60
5/13	0		6/22			7/31		576	9/08		8
5/14	0		6/23			8/01		296	9/09		17
5/15	0		6/24			8/02		420	9/10		6
5/16	684		6/25			8/03		485	9/11		11
5/17	161		6/26		1	8/04		116	9/12		9
5/18	264		6/27		0	8/05		136	9/13		20
5/19	15,099		6/28		0	8/06		190	9/14		12
5/20	1,995		6/29		0	8/07		299	9/15		5
5/21	3,713		6/30		2	8/08		341	9/16		7
5/22	76		7/01		0	8/09		383	9/17		9
5/23	3,215		7/02		3	8/10		383	9/18		4
5/24	14,507		7/03		22	8/11		327	9/19		3
5/25	3		7/04		6	8/12		363	9/20		6
5/26	523		7/05		4	8/13		272	9/21		4
5/27	1,355		7/06		9	8/14		180	9/22		2

-Continued-

Appendix Table 3. Counts of emigrant and immigrant Dolly Varden char through the Buskin River weir, 1986 (Continued).

Date	Emigrant Dolly Varden	Immigrant Dolly Varden	Date	Emigrant Dolly Varden	Immigrant Dolly Varden	Date	Emigrant Dolly Varden	Immigrant Dolly Varden	Date	Emigrant Dolly Varden	Immigrant Dolly Varden
5/28	13		7/07		29	8/15		230	9/23		1
5/29	17		7/08		12	8/16		101	9/24		3
5/30	377		7/09		67	8/17		51	9/25		2
5/31	9		7/10		51	8/18		107	9/26		1
6/01	14		7/11		177	8/19		58	9/27		6
6/02	183		7/12		385	8/20		60	9/28		28
6/03	448		7/13		240	8/21		50	9/29		27
6/04	0		7/14		906	8/22		23	9/30		7
6/05	0		7/15		587	8/23		37	10/1		62
6/06	7		7/16		115	8/24		27	10/2		43
6/07	6										
									TOTAL	40,733	24,110

Appendix Table 4. Age composition of Dolly Varden char in the Buskin River sport harvest, 1986.

	Age Class								
Sex	3	4	5	6	7	8	9	10	Total
Sexes Combined									
Sample Size	1	11	78	62	37	16	1	1	207
Percent	0.5	5.3	37.7	30.0	17.8	7.7	0.5	0.5	100.0
Standard Error	0.5	1.56	3.38	3.19	2.67	1.86	0.5	0.5	

Appendix Table 5. Mean length (mm) of Dolly Varden char in the Buskin River sport harvest, 1986.[1]

Sex	Age Class							
	3	4	5	6	7	8	9	10
Sexes Combined								
Sample Size	173	215	281	345	388	444	442	543
Standard Error	0	8.87	4.40	4.94	6.97	11.20	0	0
Sample Size	1	11	78	62	37	16	1	1

[1] Snout-to-fork-of-tail length.